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RESEARCH ARTICLE

Association of body mass index with pulmonary function in overweight young adults

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ABSTRACT

Background: Obesity is the most common metabolic disease in the world which has now become an important worldwide contributor to morbidity and mortality. Obesity can have detrimental effects on respiratory functions with increased body mass index (BMI) being associated with a reduction in lung function parameters. **Aims and Objectives:** The objective of the study was to evaluate the effects of BMI on pulmonary function in overweight young adults. **Materials and Methods:** This cross-sectional was conducted among 100 overweight medical students. The participants were examined for anthropometric parameters such as height and weight. BMI was calculated, and those having a BMI of more than 25 kg/m^2 were included in the study. Pulmonary function tests were measured in all the study participants using the computerized spirometer. The correlation was assessed between BMI and the lung function parameters. **Results:** Significant gender difference was found in forced vital capacity, forced expiratory volume in first second, and peak expiratory flow rate (PEFR). Among all pulmonary function parameters, BMI correlated significantly with PEFR in both genders. **Conclusion:** This study showed that there is a significant correlation between BMI and PEFR in both genders.

KEY WORDS: Peak Expiratory Flow Rate; Body Mass Index; Overweight; Gender Difference

INTRODUCTION

Obesity is the most common metabolic disease in the world[1] with its prevalence increasing over several decades.[2] Formerly thought to be a problem of developed countries, it has now become an important worldwide contributor to morbidity and mortality among all ages and socioeconomic groups.[3] Besides genetic predisposition, adoption of sedentary lifestyle and inappropriate intake of calorie-rich easily available junk food has made the environment conducive to the development of obesity even in childhood.[4] Patterns of diet and exercise developed in childhood are difficult to change as one grows up thus making childhood obesity a strong risk factor for adult obesity which is linked with a higher chance of premature death and disability.[3]

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Obesity has been associated with the increased incidence of cardiovascular diseases, hypertension, metabolic disorders, and pulmonary dysfunction.[5] Obesity can have detrimental effects on respiratory functions, such as alterations in the respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, lower control of breathing, and limitations in pulmonary function tests (PFT).[6] These changes in lung function are caused by fat accumulation in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm, and lungs, consequently causing a decrease in diaphragm displacement, adecrease in lung and chest wall compliance, and an increase in elastic recoil, resulting in a decrease in lung volumes, and an overload on inspiratory muscles, impairing ventilatory function.[7-9] Furthermore, the deposition of extra adipose

tissue on the chest wall has negative effects on the expansion and excursion of the rib cage, through a direct loading effect or by altering intercostal muscle function.[10] It has been pointed out by various studies that increased body mass index (BMI) is related to a reduction in lung function parameters and is also related with markers of systemic and vascular inflammation (C-reactive protein and leptin) thus suggesting that the maintenance of adequate body weight might prove essential for improving the lung function.[11-14]

Even though the interaction between obesity and PFT has been addressed previously, the results have been inconsistent among the overweight young population. Therefore, we aimed to evaluate the effects of BMI on pulmonary function in overweight young adults.

MATERIALS AND METHODS

A total of 100 overweight medical students (50 males and 50 females) in the age group of 18–25 years, were enrolled for this study. This cross-sectional study was conducted in the Department of Physiology, SKIMS Medical College, Srinagar, from January 2018 to September 2018. The students were informed about the objectives of the study and consent was obtained from them. Institutional Ethics Committee approved the study protocol. Students having a history of asthma, severe anemia, chest or abdominal pain of any cause, or history of any disease which can be expected to affect pulmonary function such as neuromuscular disorder and cardiopulmonary disorder were excluded from the study. All the subjects were nonsmokers. A detailed history was taken from each and physical examination was performed. The finding was recorded in the pro forma. The participants were examined for various anthropometric parameters such as height and weight. Weight was measured using digital scale to the nearest 0.1 kg with only light clothing, and for the determination of height, subjects were made to take off their shoes, stand upright with their head in the Frankfort plane with the heel, buttock, and occiput against the wall. Height was recorded to the nearest 0.5 cm. BMI was calculated as weight (in kg) divided by the square of height (in meters) and those having a BMI of >25 kg/m^2 were included in the study. PFTs were measured in all the study participants using the Computerized Spirometer, "Shiller's Spirometer." The subjects were asked to avoid tea, coffee, and other stimulants. After a rest for 5 min, the test was carried out. The subject was made to sit in the upright posture and made comfortable. The test was demonstrated and explained in detail to the subjects. At least three tests of acceptable effort were performed to ensure reproducibility and the best trial was selected for reporting. The following parameters were noted forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC, and peak expiratory flow rate (PEFR). All spirometric parameters were considered as a percentage of predicted on reported height and age.

Data were collected and grouped using MS Excel. Mean and standard deviation were calculated. Statistical software SPSS version 20 was used for the analysis of the data. Student's unpaired *t*-test was adopted to compare the pulmonary function measurements and physical parameters between the genders. Pearson's correlation test was used to find the correlation of BMI with respiratory parameters in both genders.

RESULTS

Among the 100 participants, 50 (50%) were males and 50 (50%) were females. All the mean values were slightly higher in males except for BMI which was slightly higher in females. The significant gender difference was found in FVC, FEV1, and PEFR ($P < 0.001$) [Table 1].

The correlation was assessed between BMI and the lung function parameters. Table 2 depicts the Pearson's correlation coefficient (*r*) between BMI and PFT parameters in male and female subjects. Among all pulmonary function parameters, BMI correlated significantly with PEFR in both males and females.

Table 1: Baseline characteristics and pulmonary function parameters of the subjects

Variable	Males (mean±SD)	Females (mean±SD)	*p* value
Age (years)	19.95±1.33	19.24±1.50	NS
Weight (kg)	67.69±7.66	66.15±7.34	NS
Height (cm)	1.68±0.07	1.59±0.08	NS
BMI (kg/m^2)	26.73±2.65	27.01±2.59	NS
FVC (L)	3.89±0.32	2.36±0.20	<0.001
FEV1 (L)	3.24±0.57	2.03±0.49	<0.001
FEV1/FVC (%)	86.23±6.58	87.67±7.67	NS
PEFR (L/min)	408.04±57.56	319.27±66.88	<0.001

BMI: Body mass index, FVC: Forced vital capacity, FEV1: Forced expiratory volume in first second, PEFR: Peak expiratory flow rate. *P<0.05, **P<0.001, NS: Not significant

Table 2: Correlation of spirometric parameters with BMI in male and female subjects

Gender	Parameter	*r*	*p* value
Males	FVC (L)	0.122	0.399
	FEV1 (L)	0.205	0.154
	FEV1/FVC (%)	0.273	0.081
	PEFR (L/min)	−0.302*	0.033
Females	FVC (L)	−0.117	0.417
	FEV1(L)	0.221	0.123
	FEV1/FVC (%)	0.225	0.116
	PEFR (L/min)	−0.332*	0.018

FVC: Forced vital capacity, FEV1: Forced expiratory volume in first second, PEFR: Peak expiratory flow rate.
*P<0.05, **P<0.001

DISCUSSION

In the present study, we tried to find out the effect of BMI on lung function parameters. Mean values of lung function parameters, namely FVC, FEV1, and PEFR were found to be significantly higher in males when compared to females. Previously conducted studies have also reported significant gender differences in lung function parameters.[15,16] Females have lower values for lung function parameters as their respiratory muscle endurance, and chest wall compliance is lower than males.[17] In addition to the anatomical and physiological differences, certain other factors such as sex hormones, sex hormone receptors, or intracellular signaling pathways may also be responsible for the gender difference in lung functions.[18,19]

It was observed that there was no significant relationship between BMI and FEV1, FVC, and FEV1/FVC in both genders, however, a significant relationship was observed between BMI and PEFR in both genders. In most of the previously conducted studies, the effects of BMI on lung function parameters are not consistent, with some studies showing significant effects[20-23] while others showing no effects.[24-27] Results similar to ours were reported by a study conducted in South India in apparently healthy adults (both obese and nonobese).[28] These differences in findings of various studies could be due to methodological differences, differences in the age group of the study population and also due to the fact that we included only overweight adults in this study. A study conducted among Indian adult males showed that obesity itself and more specifically the pattern of body fat distribution have independent effects on PEFR.[29] In healthy subjects, primary factors that affect PEFR are the strength of the expiratory muscles generating the force of contraction, the elastic recoil pressure of the lungs and the airway size.[30] In obesity, the function of respiratory muscles is impaired from the increased resistance they must overcome and from the reduced capacity of these muscles.[31] Hence, in addition to indicating that increased BMI has effects on the lung function that can cause a decrease in respiratory well-being, our study is an attempt to make overweight individuals aware about the ill effects of obesity and encourage them to adopt a healthy lifestyle to prevent the development of respiratory complaints later in life.

The strength of our study is the recruitment of subjects who were overweight but without any comorbid condition. The limitations include small sample size and all the lung function test parameters, and lung volumes were not recorded. Furthermore, the relation of pulmonary function with other markers of obesity was not explored. There is a need for conduction of longitudinal studies with larger sample size, keeping in view the distribution of body fat.

CONCLUSION

This study showed that there exists a significant correlation between BMI and PEFR (an objective measure of airflow resistance in the lungs) in both genders suggesting an increased pulmonary risk with increased BMI.

REFERENCES

1. Formiguera X, Cantón A. Obesity: Epidemiology and clinical aspects. Best Pract Res Clin Gastroenterol 2004;18:1125-46.
2. Ogden CL, Fryar CD, Carroll MD, Flegal KM. Mean body weight, height, and body mass index, united states 1960-2002. Adv Data 2004;347:1-7.
3. World Health Organization. Obesity and Overweight. Fact Sheet No. 311; 2006.
4. Yusuf S, Hawken S, Ounpuu S, Bautista L, Franzosi MG, Commerford P, *et al.* Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: A case-control study. Lancet 2005;366:1640-9.
5. Harik-Khan RI, Wise RA, Fleg JL. The effect of gender on the relationship between body fat distribution and lung function. J Clin Epidemiol 2001;54:399-406.
6. Ray CS, Sue DY, Bray G, Hansen JE, Wasserman K. Effects of obesity on respiratory function. Am Rev Respir Dis 1983;128:501-6.
7. Koenig SM. Pulmonary complications of obesity. Am J Med Sci 2001;321:249-79.
8. Lazarus R, Sparrow D, Weiss ST. Effects of obesity and fat distribution on ventilatory function: The normative aging study. Chest 1997;111:891-8.
9. Chinn DJ, Cotes JE, Reed JW. Longitudinal effects of change in body mass on measurements of ventilatory capacity. Thorax 1996;51:699-704.
10. Poulain M, Doucet M, Major GC, Drapeau V, Sériès F, Boulet LP, *et al.* The effect of obesity on chronic respiratory diseases: Pathophysiology and therapeutic strategies. CMAJ 2006;174:1293-9.
11. Breyer MK, Rutten EP, Spruit MA, Hop WC, Postma DS, Wouters EF. Systemic inflammation in patients with chronic obstructive pulmonary disease: Results from the cosmic study. Open J Respir Dis 2012;2:63-72.
12. Sin DD, Man SF. Impaired lung function and serum leptin in men and women with normal body weight: A population based study. Thorax 2003;58:695-8.
13. Aronson D, Roterman I, Yigla M, Kerner A, Avizohar O, Sella R, *et al.* Inverse association between pulmonary function and C-reactive protein in apparently healthy subjects. Am J Respir Crit Care Med 2006;174:626-32.
14. Saikia K, Barman S, Deka J. Effect of body mass index (BMI) on forced vital capacity (FVC) and forced expiratory volume in first second (FEV1) in young healthy males. Int J Sci Res 2016:5. Available from: https://www.worldwidejournals.com/international-journal-of-scientific-research-(IJSR)//articles.php?val=ODE2Mw==&b1=29&k=8. [Last accessed on 2018 Jun 22].
15. Behera AA, Behera BK, Dash S, Mishra S. Variation of pulmonary function tests with relation to increasing age in healthy adults. Int J Health Sci Res 2014;4:36-41.
16. Budhiraja S, Singh D, Pooni PA, Dhooria GS. Pulmonary functions in normal school children in the age group of 6-15 years in north India. Iran J Pediatr 2010;20:82-90.
17. Afaf A, Shaheena, Salwa B, El-Sobekyb Amal H. Anthropometric measurement and ventilatory function in

obese and non-obese female college students. Middle East J Sci Res 2011;7:634-42.
18. Card JW, Zeldin DC. Hormonal influences on lung function and response to environmental agents: Lessons from animal models of respiratory disease. Proc Am Thorac Soc 2009;6:588-95.
19. Algadir A, Aly F, Zafar H. Sex based difference in lung functions of Saudi adults. J Phys Ther Sci 2012;24:5-9.
20. Watson RA, Pride NB. Postural changes in lung volumes and respiratory resistance in subjects with obesity. J Appl Physiol 2005;98:512-7.
21. Richard L, Nzekwu MU. The effects of body mass index on lung volumes. Chest 2006;130;827-33.
22. Cheryl M. Salome, Gregory G. King and Norbert Berend: Physiology of obesity and effects on lung function. J Appl Physiol. 2010;108:206-11.
23. Biring MS, Lewis MI, Liu JT, Mohsenifar Z. Pulmonary physiologic changes of morbid obesity. Am J Med Sci 1999;318:293-7.
24. Jenkins SC, Moxham J. The effects of mild obesity on lung function. Respir Med 1991;85:309-11.
25. Sutherland TJ, Cowan JO, Young S, Goulding A, Grant AM, Williamson A, *et al.* The association between obesity and asthma: Interactions between systemic and airway inflammation. Am J Respir Crit Care Med 2008;178:469-75.
26. Collins LC, Hoberty PD, Walker JF, Fletcher EC, Peiris AN. The effect of body fat distribution on pulmonary function tests. Chest 1995;107:1298-302.
27. Al Ghobain M. The effect of obesity on spirometry tests among healthy non-smoking adults. BMC Pulm Med 2012;12:10.
28. Behera AA, Behera BK, Dash S, Mishra S. Effect of body mass index on gender difference in lung functions in Indian population. Int J Clin Exp Physiol 2014;1:229-31.
29. Saxena Y, Sidhwani G, Upmanyu R. Abdominal obesity and pulmonary functions in young Indian adults: A prospective study. Indian J Physiol Pharmacol 2009;53:318-26.
30. Sahebjami H. Dyspnea in obese healthy men. Chest 1998;114:1373-7.
31. Gibson GJ. Obesity, respiratory function and breathlessness. Thorax 2000;55 Suppl 1:S41-4.

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